BIONOMICS OF THE BARK BEETLE PREDATOR, THANASIMUS DUBIUS FAB. (COLEOPTERA: CLERIDAE) [1]

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Many species of checkered beetles are well known predators of bark beetles; consequently, the adults of these insects are commonly observed on the outside bark while the larvae are in the inner-bark of trees infested with bark beetles. Inasmuch as checkered and Ostomid beetles are usually the most abundant insect predators of bark beetles and because only a few intensive studies have been made on these insects it was thought desirable to evaluate the effectiveness of two species of these common predators, *Thanasimus dubius* Fab. and *Temnochila virescens* Mann. Therefore, a study on these relationships was undertaken in 1964 and conducted over the following two year period, 1964 to 1966.

Part of these studies entailed collecting a considerable amount of information on the life history and ecology of these predators and for one of these, the checkered beetle, *Thanasimus dubius*, the results are presented in this paper. A future paper will deal with the ostomid beetle, *Temnochila virescens*.

About the same time the present study was made Thatcher and Pickard (1966) also studied the predator, *Thanasimus dubius*, in which the host prey was the southern pine beetle, *Dendroctonus frontalis* Zimm. The results of their work concerning the life history were somewhat similar to those presented here, but for certain aspects we have more detailed data.

Other rather intensive studies of clerid beetles as predators of bark beetles were those of Person (1940) and Struble (1942). Person studied *Thanasimus lecontei* (Wolc.) whereas Struble was concerned with *Enoclerus sphegeus* Fab.

In a third paper, which is scheduled for future publication, the potential effectiveness of both *Thanasimus dubius* and *Temnochila virescens* in regulating bark beetle populations will be discussed.

[1] This study was supported jointly by the Southern Forest Disease and Insect Research Council and Duke University. Accepted for publication November 3, 1969.

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Methods of Study

Both field and laboratory studies were used. Ten pines (*Pinus taeda* L.) were felled in each of twelve different areas of the Duke University Forest which is located near Durham, North Carolina. These trees were cut at four different times during the year—spring (April), early summer (June), late summer (August), and fall (September). This experimental design resulted in infestations by bark beetles at various times during the warmer seasons so that activities of the associated predators could be followed in the field. The prey bark beetles consisted mostly of the 5-spined pine engraver, *Ips grandicollis* (Eichh.) and to a lesser extent the small 4-spined *I. avulsus* Eichh. and the large 6-spined *I. calligraphus* Germ. The felled trees were observed periodically to determine the presence of infestations by the pine engravers and the associated predators. Starting three weeks after each group of trees had been cut, and continuing thereafter at weekly intervals for a period of twelve weeks, bolts two feet long

Table 1. Length of the developmental periods for the predator, *Thanasimus dubius* and its host, the pine engraver, *Ips* spp.

Insect Species	Time of Year			
	Spring	Early Summer	Late Summer	Fall
	Days	Days	Days	Days
Ips spp	34–37	31–35	33–35	32– 34
T. dubius	67–83	Absent[4]	Absent[4]	240–262[5]

[4] Only adults were observed on the outside bark, larvae and pupae were not found.
[5] The long developmental period was because the larvae passed the winter in this state.

were cut from the boles of the felled trees. The bark was removed from these samples so that the bark beetles and predators present in the inner-bark could be identified, counted, and their developmental stage determined.

In the laboratory the predators were reared in Petri dishes. The inside of the bottom plates were usually covered with moistened filter paper so as to produce moisture conditions similar to those in the inner-bark where the immature stages of the predators normally live. The larval stages of the predators were fed with larvae and pupae of the pine engraver beetles (*Ips* spp.) whereas the adult predators were fed with adult engraver beetles. Various constant temperatures were used for the laboratory studies. For the oviposition studies a small piece of pine bark had to be enclosed with each pair of beetles. This provided a suitable place for egg deposition.

Results

The data collected on the life cycle of the checkered beetle, *T. dubius*, in the field are summarized in Tables 1 and 2, whereas similar data collected in the laboratory are presented in Table 3. Mortality data for the developmental stages at the various temperatures are presented in Table 4.

Table 2. Development of *Thanasimus dubius* in the field

Time of Year	Instar					
	1	2	3	4	Pupal	Total
	Days	Days	Days	Days	Days	Days
Spring	4	21	7	4	17	53
Autumn	4	33	166[6]	6	19	228

[6] Extended length for this stadium was because the insects passed the winter in this instar.

Table 3. Development of *Thanasimus dubius* at various constant temperatures

Stage of Development	Temperature °C				
	20	25	30	35	37½
	Days	Days	Days	Days	Days
Egg	13 (1.2)[8]	11 (0.9)	8 (0.7)	10 (1.6)	16 (1.2)
Larval Instars					
1	9 (1.4)	7 (1.1)	12 (1.7)	15 (1.4)	16 (2.6)
2	24 (2.8)	20 (2.1)	31 (2.0)	34 (2.4)	38 (2.3)
3	11 (1.7)	8 (0.9)	14 (1.2)	16 (1.8)	21 (3.3)
4	10 (1.3)	9 (1.5)	15 (1.3)	18 (1.9)	23 (2.3)
Pupa	22 (1.6)	18 (1.0)	14 (1.0)	16 (1.4)	20 (21.)
Total	89	73	94	109	134

[8] Values in parentheses are standard errors. Five replicates were used for each temperature.

Longevity of the adults when kept separately in Petri dishes varied from 21 to 57 days. Longest survival occurred at 25° C ($\bar{x} = 51$ days) and the shortest at 37½° C ($\bar{x} = 28$ days). The averages and standard errors for the five replicates used for each of the five temperatures were as follows: 20° C, 44± 2.3 days; 25° C, 51± 2.6 days; 30° C, 45± 1.6 days; 35° C, 29± 1.8 days; 37½° C, 28± 2.3 days.

TABLE 4. Mortality suffered by *Thanasimus dubius* during the developmental period

Stage of Development	Temperature °C				
	20	25	30	35	37½
	Percent Mortality[9]				
Egg	31.0	28.0	34.0	59.0	83.0
Larval Instar					
1	33.0	26.6	27.0	22.0	11.5
2	2.2	5.0	5.1	4.4	1.8
3	2.0	3.6	4.1	2.3	0.7
4	1.2	2.6	2.4	1.1	0.4
Pupa	8.1	5.8	5.5	3.7	1.1
Total	77.5	71.6	78.1	92.5	98.5

[9] Mortality values for each stage are based on the total population at the beginning (e.g., number of eggs). The number of insects used for each stage at each temperature varied from 27 to 74 with the average being 48.2.

The average preoviposition period from the time of beetle emergence to when the first egg was laid varied from 3 days at 20° C to 7 days at 37½° C. At 25° C and 30° C the length was 4 days and for 35° C it was five days. Five replicates were used at each temperature studied with the range for each varying from 3 to 4 days at 20° C to 6 to 8 days at 37½° C. Subsequently, the oviposition period continued for an average of 21 days at 37½° C to 47 days at 25° C.

Total egg production for five pairs of these predators varied from an average of 11 to 112. The average number of eggs per female for the various temperatures were as follows: 20° C, 81 eggs; 25° C, 106 eggs; 30° C, 112 eggs; 35° C, 37 eggs; 37½° C, 11 eggs. These were produced at an average rate of 3.6 to 19.6 eggs per week.

Rather dry conditions were better than a moist environment for larval development. Mortality was 61.1 percent when the insects were reared on moist filter paper, but was only 41.3 percent when the paper was kept dry. A total of 80 larvae were used in this study.

Whenever two *T. dubius* larvae were enclosed together in a Petri dish, one commonly killed and ate the other. When other food (bark beetle larvae or pupae) was present, however, the rate of cannibalism was reduced to about 35 percent when two larvae were caged together for a period of two days. When the usual food consisting of bark beetle larvae or pupae was absent, however, one larva always soon destroyed the other. The adult beetles, on the other hand, were not cannibalistic even in the absence of other food.

In the field, the density of the *T. dubius* populations, on the outside of logs infested with pine engravers was higher, both during the spring (averaging 1 beetle per square foot of bark) and the fall (0.8 beetles per square foot) than it was during the three hot summer months from June through August. During the latter period the average was 0.5 beetles per square foot. Larval populations of the earlier instars of this predator also averaged about 1 per square foot of inner-bark surface during both the spring and fall seasons. However, this density decreased as the larvae matured so that for the last (4th) larval instar and the following pupal stage there averaged only 0.5 insects per square foot of inner-bark. As can be seen from the data in Table 1, there were no immature stages of *T. dubius* present in the logs infested with *Isp* spp. during the three hot summer months of June, July, and August.

Discussion

The data presented in Tables 1 to 4 show that the bark beetle predator, *T. dubius*, developed fastest and survived better at the cooler temperatures that occur during the spring and fall seasons. Throughout the hot summer months from June through August, the immature stages of this predator were absent in logs exposed in the field and infested with bark beetles even though the adults were present. During the hot summer season this ecological niche in the inner bark was consistently and completely occupied by another common predator, *Temnochila virescens*.

Other data presented here pertaining to eggs production, incubation period, and development from egg to adult of *T. dubius* in the field are somewhat similar to those reported by Thatcher and Pickard (1966).

As with most preliminary types of studies, this one suggests several relationships that should be investigated more thoroughly. One aspect that should be clarified is to determine why the immature stages are absent during the hot summer months. As stated previously, the inner-bark of logs infested with bark beetles during the summer was occupied by another predator, *Temnochila virescens*. If *T. dubius* did not produce a generation during the three hot summer months the beetles either had to survive as adults until autumn, at which time they reproduced, or they produced a summer generation with the larvae feeding on some prey other than bark beetles. In either case, the density of the immature stages of *T. dubius* was as large in the autumn as it was in the spring. It is suspected that during mid-summer the clerid larvae were destroyed by the other common predator, *Temnochila virescens*.

Another somewhat unexpected result was that the rate of development decreased considerably at a temperature of only 30° C. At 25° C the rate of development from time of oviposition to the imago was 23, 33, and 46 percent faster than it was at 30° C, 35° C, and $37\frac{1}{2}$° C, respectively. This adverse effect of higher temperatures agrees with the other results indicating that *T. dubius* succeeds better at cooler temperatures.

And, lastly, the interspecific relationship between the two predators, *Thanasimus dubius* and *Temnochila virescens*, should be investigated more thoroughly especially at cooler temperatures. This type of study may help to explain the fate of the ostomid larvae in the spring and fall and the clerid larvae in the summer.

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